Effect of low dose radiation on rennet's ability to curdle milk

Dan Andrews[1], Kecia Goodman[1], Dillon Drury[2], Dr. Lester Wilson[3]
[1]- DOE ACTS Participants, [2]- Undergraduate Research Assistant, Iowa State University,
[3]- University Professor Food Science and Human Nutrition, Iowa State University

BACKGROUND: Cheese Making

Cheese is made from curdled milk. The most common way to curdle milk is to use an enzyme called rennet. This enzyme is found in the lining of the fourth stomach of calves. However, in 1990 a method for growing rennet outside of the calves was developed, so much of the rennet today is grown from engineered yeast.

BACKGROUND: Space Travel –

Mass & Radiation Issues

When sending people and supplies into space, mass is a huge factor. The more mass you put into the spacecraft, the more fuel required to get off the ground. Fuel not only is expensive, it takes up space which could be used for supplies. This means that supply lists are carefully calculated. Because of the issue of mass, low heat non-fat dry (NFDM) milk will be shipped to space rather than liquid milk.

Radiation found in space is considered low dose. Although it is harmful to humans, this low dose does not kill microorganisms. Its effect on food is being studied. Should space radiation damage food supplies, then this must be accounted for prior to launching into space for a long term Mars Mission.

PURPOSE OF RESEARCH

Long term manned space missions, both to a Lunar Outpost and to Mars, will require the astronauts to make their own food, including cheese. Our project studies the effect of simulated space radiation on the enzyme rennet. How much radiation can the rennet experience and still be effective?

METHODS

In this lab, low heat non-fat dry milk (NFDM) is mixed with water, the enzyme rennet is added. A viscometer is then used to measure the viscosity of the milk as it curdles. A water bath was used to ensure that the milk remained at the optimal temperature for the rennet enzyme (33^{o} C).

The independent variable in this lab is the gamma radiation applied to the rennet. (0 Gray (Gy), 1 Gy, 3 Gy, or 5 Gy). The dependent variable is the amount of time required to reach viscosities of 1000 centi-poise (cP), 10,000 cP, and 100,000 cP.

As an additional consideration this experiment was conducted adding different masses of rennet. Three trials at each mass and radiation level were required. For trials that had more rennet added, curdling began to occur within 45 seconds. This meant that if there was a delay in attaching the viscometer, data would be missed.

Each trial was video recorded so it could be analyzed and the exact time, temperature, and viscosity could be recorded.

ACKNOWLEDGEMENTS

Thank you to Dr. Wilson for allowing me to work in his food science lab and for all the time he has given helping me with this project. Thank you to Dr. Fred A. Payne, Professor of Food Engineering, University of Kentucky, for providing the low heat non-fat dry milk. Thank you to Karla Albert, Chr. Hansen Inc., for providing the rennet. Thank you to Dr. Graciela Wild Padua, Department of Food Science and Human Nutrition, University of Illinois for radiating our samples of rennet. Thank you to Dr. Michele Perchonok, Ph.D., Shuttle Food System Manager, Advanced Food Technology, NASA/JSC, for taking the time to visit with us and show us around the her lab at NASA. Thank you to the U. S. DOE Office of Science for funding ACTS and to Ames Laboratory for hosting this program. A special thank you to Dr. Adah Leshem-Ackerman for all the support and leadership she has given us through out the ACTS program. And finally thank you to all participants of the ACTS program, with whom this program has been such an enjoyable experience.

DISCUSSION

Because this project has application on space missions, the process has as much importance as does the data. The viscometer used in this project only measured the upper 3 inches of the milk. It was discovered that in samples with less rennet added the viscosity at the top of a 300 mL test tube could be 100,000 cP, but still have milk remaining at the bottom of the test tube. Waste will create additional problems for the astronauts. We found that adding more rennet to the milk caused it to curdle more quickly and completely. Further work is is underway to determine the amount of time required to completely curdle a test tube of milk at each mass and radiation level.

Time to astronauts is a valuable commodity. A decision about which is more valuable, the time required to make curds using less rennet, or the cost of shipping more rennet (mass) on the missions (Referred to by NASA as a Trade Study).

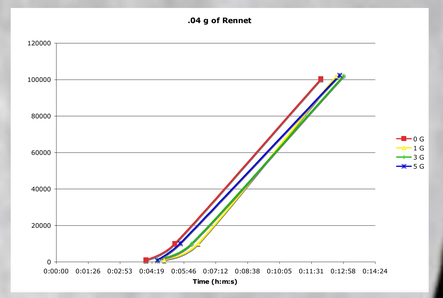

Figure 1

RESULTS

At this time our results need statistical analysis.

Figure 1 above is a graph of one set of samples. The results (in all samples) seem to indicate that there may be a relationship between the amount of radiation applied to the rennet and the time required for it to curdle milk. However, it is not as great as the experimenter expected to see. The effect shown may be within the margins of experimental and statistical error.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF
Food Science and
Human Nutrition